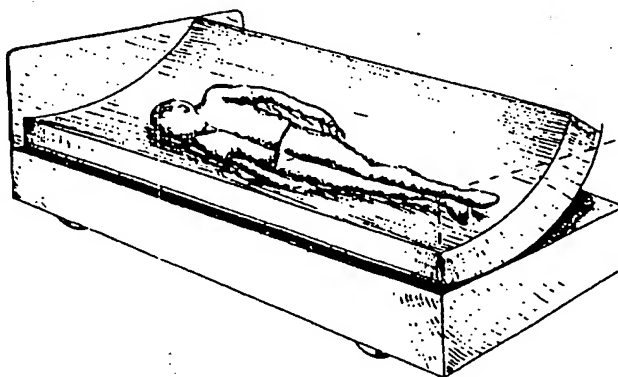


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(54) Title: A BED AND MATTRESS SUPPORT ASSEMBLY



## (57) Abstract

A bed (50) and mattress support assembly (10) for a bed that is adapted for use by long term infirm persons, enables pressures on the body resulting from long periods in a lying position to be reduced. In one configuration the mattress support assembly (10) of the bed lies flat in the form of an ordinary hospital bed, but a first controllable actuator (100) enables the mattress support assembly (10) to be formed into a second configuration having trough-shaped structure with the longitudinal edges curved upwardly with respect to the centre. When in the second configuration a second controllable actuator (110) enables the mattress support assembly to be slowly and cyclically rocked from side to side over a period of time. The rocking motion is carried out in incremental tilting movements. For example, one cycle of rocking movement may be carried out over a period of 100 minutes in incremental angular movements of several degrees each ten minute interval. The mattress support assembly can also be articulated at transverse hinged points which enable a third controllable actuator (60) to form the mattress support assembly (10) into a sitting configuration. The cyclical rocking movement of the bed allows a patient's weight to be distributed over different parts of the body during the cycle, which can reduce the deleterious effects of being bed ridden.

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## A BED AND MATTRESS SUPPORT ASSEMBLY

This invention relates to a bed, and a mattress support assembly for a bed which is particularly suitable for long term infirm persons.

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For persons who are required to spend long periods of time in bed for reasons of infirmity, such as paralyses, coma or the like, whether that be in a hospital, nursing home or private premises, numerous difficulties are known to arise from lack of movement whilst bed ridden. For example, poor blood circulation and decubitus ulcers or bedsores are known to result from prolonged contact with the bed support surface in a generally immobile condition. Consequently, it is common for a person in this condition to be periodically moved from one lying position to another. This requires that a carer such as a nurse physically move the person every couple of hours such as by rolling the person onto one side or the other. Often this procedure necessitates waking the person several times during a night, if that person is capable of being woken and obviously requires the periodic physical presence of a carer.

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The present invention is directed to a bed and mattress support assembly for a bed which is capable of tilting from side to side a mattress placed thereon and thus obviate the need for a carer to physically move a person on the mattress.

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In accordance with the present invention there is provided a bed having a mattress support assembly which is moveable between a flat configuration and a trough shaped configuration and, when in said trough shaped configuration, is tiltable from side to side with respect to its longitudinal axis.

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The present invention also provides a mattress support assembly for a bed adapted for use by long term infirm persons, the mattress support assembly comprising a bed plate on which a mattress is in use positioned, and an actuator mechanism for moving the bed plate from a first configuration in which the bed plate is supported in a substantially flat and horizontal orientation to a second configuration in which the bedplate is supported in a longitudinal

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trough shaped arrangement, the actuator mechanism also being capable of tilting the bed plate from side to side with respect to its longitudinal axis when in said trough shaped arrangement.

The present invention also provides a mattress support assembly for a bed comprising a  
5 longitudinal bed plate for support of a mattress, the bed plate being flexible perpendicular to its longitudinal axis to enable the bed plate to be moved from a first configuration in which the bed plate is supported substantially flat and horizontal to a second configuration in which the bed plate is flexed about its longitudinal axis and supported in a trough shaped arrangement, the mattress support assembly including means for tilting the bed plate from side  
10 to side when in said trough shaped arrangement.

The present invention further provides a bed adapted for long term infirm persons, comprising:

a base having a substantially horizontal support frame;  
15 a mattress support assembly comprising a longitudinal bed plate for use in supporting a mattress thereon, the bed plate being flexible perpendicular to its longitudinal axis, the mattress support assembly further comprising a cradle support frame positioned beneath said bed plate; and

an actuator mechanism coupled between the base and mattress support assembly for  
20 movement thereof with respect to the base, the actuator mechanism comprising a first actuator for moving the bed plate from a first position wherein the bed plate is supported substantially flat and horizontal on the support frame of the base to a second position wherein the bed plate is supported by said cradle support frame in a trough shaped configuration, flexed about its longitudinal axis, and a second actuator for tilting the cradle support frame and bed plate  
25 when in said second position from side to side with respect to said longitudinal axis.

In one form of the invention, the bed plate comprises a plurality of longitudinal panels which are coupled to one another with a degree of flexibility, which enables the bed plate to flex about its longitudinal axis. Preferably, in a first configuration the bed plate is supported on  
30 a substantially flat and horizontal frame, providing a flat surface for a mattress. The frame

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may be coupled to a bed base, for example. In order to form the bed plate into a longitudinal trough shaped arrangement, a cradle support frame is preferably provided beneath the bed plate and having a plurality of generally u-shaped frame members spaced along the longitudinal length of the bed plate. Preferably, the cradle support frame is  
5 moveable with respect to the flat support frame in such a way as to allow the cradle support frame to be raised above the flat support frame, in use, taking with it the bed plate. A mechanical lever arrangement together with, for example, an electrically operated actuator, may be provided for the purposes of raising the cradle support frame.

10. In the preferred form of the invention, the cradle support frame is itself supported by a bed base through a longitudinally extending axle which allows pivoting of the cradle support frame and bed plate supported thereon from side to side. An additional actuator may be coupled to tilt the cradle support frame from side to side with respect to the bed base, pivoting about the axle. In the preferred form of the invention, the tilting actuator is  
15 controlled so as to rock or tilt the cradle support frame from one side to the other through a series of incremental steps. For example, the cradle support frame may rock through a total angle of, say,  $60^\circ$  in a series of ten steps, wherein during each incremental tilting movement the cradle support frame moves through about  $6^\circ$ . Furthermore, each rocking cycle preferably takes place over a period of time between several minutes and several hours. In  
20 one form of the invention, for example, the time between incremental tilting movements is selectable to be five, ten or fifteen minutes, such that each rocking cycle takes 50, 100 or 150 minutes respectively.

Preferably, each of the elongate panels of the bed plate is articulated in several places, such  
25 that the bed plate itself is hinged at several places along its longitudinal axis. The articulated panels allow the bed plate to be moved from a flat configuration to a hinged configuration which is suitable to allow a person to be supported in a sitting position. For this purpose, a further actuator may be provided to raise hinged sections of the bed plate out of the flat horizontal plane.

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The invention is described in greater detail hereinafter, by way of example only, with reference to the accompanying drawings, wherein:

Figure 1 is a top view of a bed plate for support of a mattress thereon;

Figure 2 is an end perspective view of the bed plate in a trough shaped configuration;

5 Figure 3 is an end perspective view of a cradle support frame;

Figure 4 is a top view of a hinge for articulating panels of a bed plate;

Figure 5 is a side view of the hinge;

Figure 6 is an end view of the hinge;

Figure 7 is an end view of a section of a panel for forming the bed plate;

10 Figure 8 is a side view of a bed frame having a bed plate supported flat and horizontally thereon, illustrating a mechanism for articulating the bed plate;

Figure 9 is a side view of the bed frame illustrating the bed plate in articulated position;

Figure 10 is a cross sectional side view of the bed frame illustrating the cradle support  
15 frame in lowered position;

Figure 11 is a side cross sectional view of the bed frame showing the cradle support frame in raised position;

Figure 12 is an end view of the bed frame with cradle support frame in lowered position;

20 Figure 13 is an end view of the bed frame showing the cradle support frame in raised, centred position;

Figures 14 and 15 are end views of the bed frame with cradle support frame in raised position and illustrating tilting of the cradle support frame to each side, respectively;

Figure 16 is a perspective view illustrating a bed constructed according to an  
25 embodiment of the invention with a mattress support assembly thereof in flat configuration;

Figure 17 is a perspective view of the bed illustrating the mattress support assembly in articulated configuration;

Figure 18 is a perspective view of the bed illustrating the mattress support assembly in curved and tilted configuration;

30 Figures 19 to 25 are flow charts illustrating an example of a control procedure for

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actuators for controlling a mattress support assembly according to an embodiment of the invention; and

Figure 26 is a block diagram of a controller for the actuators of the preferred embodiment, for implementing the control procedures illustrated in Figures 19 to 26.

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A preferred embodiment of the present invention is described in detail hereinbelow, comprising a bed which is particularly suitable for long term infirm persons who spend extended periods of time in bed. The bed has a mattress support assembly which is adaptable into three main configurations. A form of bed plate is provided for support of the mattress, and the bed plate has a degree of flexibility about its longitudinal axis, and is articulated at several locations along its length. In a first configuration the bed plate is supported in a flat horizontal orientation by a bed frame, in which case the mattress lies flat like a standard bed, as illustrated in Figure 16. In a second configuration, sections of the articulated bed plate are raised from the bed frame, so that the bed plate and mattress take on an articulated configuration to allow a user to be supported in a sitting position, as illustrated in Figure 17. In a third configuration, the bed plate is flexed about its longitudinal axis and supported in a bent trough shaped arrangement. In this third configuration a cradle support frame which supports the bed plate is pivotable about a longitudinal axle, which allows the curved bed plate and mattress thereon to be cyclically tilted from side to side. This cyclical tilting or rocking causes the weight of a person on the bed to be distributed over different areas of the body during the cycle, thereby alleviating some of the medical difficulties discussed above. The curved and tilted arrangement is illustrated in Figure 18.

A bed plate 10 is illustrated in Figure 1, comprising a plurality of elongate panels 12 which are coupled to one another edge to edge to form the generally flat bed plate which is suitable for supporting a mattress thereon, in use. The bed plate 10 may typically be of the order of 2 metres in length and 1 metre in width. In this instance the bed plate 10 is comprised of 10 panels 12 which extend longitudinally of the bed plate, and each of which are articulated at 3 locations by way of hinges 20.

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Figure 7 illustrates an end view of a single panel 12 which, in the preferred embodiment, is constructed from extruded anodized aluminium. The panel 12 has a generally flat box construction which forms two side by side compartments 14 within the panel structure. Along one edge of the panel 12 there is formed a circular beading 16 which extends from the edge  
5 along the length of the panel. Along the other edge there is formed a partially closed circular cross section groove 18 which is adapted to receive the circular cross section beading 16 of an adjacent panel. With the beading 16 of one panel snap fit within the groove 18 of another panel, the two panels are thereby joined together, with a degree of flexibility between the panels afforded by rotation of the beading 16 in the groove 18 to an extent allowed by the  
10 clearance between the adjacent box construction edges of the panels. For the present purposes, a relative flexibility between adjacent panels of about 7° to 9° is considered adequate.

Each of the panels 12 forming the bed plate 10 is in fact formed in four sections 12a, 12b,  
15 12c and 12d which are interconnected by way of hinges 20. For example, for a particular panel 12, section 12a is hingedly connected to section 12b, section 12b is also hingedly connected to section 12c, and section 12c is hingedly connected to section 12d. The respective sections 12a, 12b, 12c, 12d are interconnected to respective panel sections of at least one adjacent panel by way of the previously described beading and groove arrangement  
20 formed on the edges of the panels. Figures 4, 5 and 6 illustrated top, side and end views respectively of a hinge 20 for coupling sections of a panel 12 to one another. The hinge 20 is formed in two primary portions 22 which are identical and which interfit with one another by way of interfitting tabs and notches which align to form a passage allowing a hinge pin 28 to be inserted therein. The portions 22 are thus able to pivot with respect to each other about  
25 the hinge pin 28. Each portion 22 is formed with a pair of hinge extensions 24. With the hinge portions 22 fitted together, the hinge extensions 24 of the respective hinge portions extend in opposite directions perpendicularly to the axis of hinge pin 28. The hinge extensions 24 each have a generally rectangular cross section, and are sized to fit snugly within the space 14 in the end of a panel section. Thus, with the hinge extensions 24 of one  
30 hinge portion 22 fitted into the pair of spaces 14 of one panel section and the hinge extensions



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24 of the other hinge portion fitted into the spaces 14 of another panel section, the two panel sections are hingedly coupled by way of the hinge 20. The hinge portions 24 may be secured within the spaces 14 of a panel section by way of, for example, glue, screws or any other suitable fixing arrangement as will be apparent to those skilled in the art.

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Figure 8 is a cut away side view of the bed 50 of the preferred embodiment, with some components removed in order to clearly illustrate articulation of the bed plate 10 and the mechanism for achieving articulation of the bed plate from a flat configuration to an arrangement for upright seating of a person on the bed. The bed comprises a generally rectangular box frame having bottom frame members 52 and horizontal top frame members 56 which are supported from the bottom frame members 52 by way of upright frame members 54. In a first configuration the bed plate 10 is supported in a flat arrangement horizontally on the upper surface of the top frame members 56. In order to raise the bed plate 10 into a seated position by articulation of the panels 12, a first actuator mechanism 60 is arranged within the space bounded by the bed frame and coupled between the bed frame and bed plate 10. The first actuator mechanism 60 comprises an electric actuator 62, such as a suitable electric screw motor which, when activated, affects extension and retraction of extender arm. The electric actuator 62 is fastened to the bottom frame member of the bed, and the extendable/retractable end of the extender arm is coupled to one end of a short lever arm 64. The other end of lever arm 64 is pivotally coupled to the bottom frame member 52 at a pivot connection 66, and a second lever arm 68 is fastened to pivot together with the first lever arm 64. The lever arm 68 is also pivotally connected to a third lever arm 70 which in turn is pivotally connected to one end of a head support arm 72. The head support arm 72 pivots about a connection to the upper frame member 56, and at its end distal to its connection to pivot arm 70 is coupled to a head support cross member 76 which extends across the width of the bed plate 10 in contact with the underneath surface thereof adjacent the head of the bed 50 near one end of the panels 12a of the bed plate.

The foot end of the bed 50, beneath the bed plate panel sections 12d and 12c is arranged with a foot support frame comprising longitudinal members 82 and foot support cross members 84,

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86 which extend across the width of the bed plate 10 beneath the panel sections 12d and 12c respectively. Adjacent the foot support cross member 84 nearest the foot of the bed the longitudinal member 82 is pivotally connected to a fourth lever arm 90 which pivots about a connection 88 to the top frame member 56. Adjacent the foot support cross member 86,  
5 a fifth lever arm 80 extends from the longitudinal member 82 to a pivotal connection at the bottom frame member 52 adjacent the electric actuator 60 to stop a connecting member 78 couples the fifth lever arm 80 intermediate its ends to the second lever arm 68.

It will be appreciated that whilst only one set of the components comprising lever arms 64,  
10 68, 70, 80 and 90, support members 72 and 82 and connecting member 78 are illustrated in Figures 8 and 9, these components are preferably duplicated on each side of the bed, with a single electric actuator 62 driving both sets of components through lever arm 64 and a transverse axle at the pivotal connection 66. Thus, transverse connections between the two sets of components would be provided by the axle 66 and the transverse support members 76,  
15 84 and 86.

With the actuator 62 in the retracted position the bed plate 10 lies flat and horizontal on the upper frame members 56, with the support cross members 76, 84 and 86 resting against the underneath surfaces of portions of the panel sections 12a, 12d and 12c, respectively. This  
20 is the configuration illustrated in Figure 8. If the actuator 62 is controlled so as to extend its extender arm, the action of the lever arms 64, 68, 70 and 80, together with support arms 72, 90 and connecting arm 78 causes the bed plate to articulate into the configuration illustrated in Figure 9. In this case, the narrow panel section 12b remains horizontal and in contact with the upper frame members 56, whilst the panel sections 12a and 12c coupled thereto extend  
25 at an angle upwards from the bed frame. The panel section 12a forms a back rest, supported by the cross member 76 at the end of back support member 72. The angled panel section 12c forms a support for the thighs of the user, and is supported underneath by cross member 86, which bears primarily upon the lever arm 80. The panel section 12d of the bed plate 10 extends from the end of panel section 12c and angled slightly downward therefrom to provide  
30 a foot rest for the user. The panel section 12d is supported from beneath by cross member

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84 which bears primarily on lever arm 90.

It will be appreciated by those skilled in the art that as the actuator mechanism 60 moves the bed plate 10 from the flat configuration shown in Figure 8 to the articulated configuration shown in Figure 9 that the cross members 76, 84 and 86 must move over the underneath surface of the bed plate 10. Thus, it is preferred that these cross members be provided with rollers or a low friction material such as a plastics coating so that they may move relatively easily over the bed plate surface without unnecessarily scratching the surface or making unnecessary noise.

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In order to able the bed plate and mattress thereon to be formed into a curved trough shaped configuration for rocking or tilting thereof, a cradle frame support 30 is also provided, illustrated in perspective view in Figure 3. The cradle support frame 30 is constructed about a central axle 32 upon which the cradle support frame is able to pivot when insitu. A plurality of generally u-shaped frame members 34 are attached at longitudinal intervals along the length of the axle 32, extending outward and upwardly from the axle. Respective ends of the u-shaped frame members 34 are coupled together along the length of the axle, with the exception of gap 40, by edge railings 36. The bed plate 10, when supported by the cradle support frame 30, forms a curved trough shape by incremental angular displacement between the individual panels 12, as illustrated in Figure 2. In order to allow the ten panels 12 of the bed plate to seat well on the u-shaped frame members 34, in use, the upper edges of the frame members 34 comprise a series of straight edges corresponding in width to the panels 12. The cradle support frame 30, like the bed frame and various actuating mechanisms is preferably constructed from chromed steel. Two of the u-shaped frame members 34 have rocking extensions 38 which extend below the axle 32.

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Figures 10 and 11 illustrate the bed 50 in cross sectional view fitted with the cradle support frame 30 and cradle raising mechanism 100. When in the lowered position as shown in Figure 10, the cradle support frame 30 fits within the frame of the bed, with the side railings 36 resting within recesses of the upper frame cross members 56 (Figure 12) so as to be flush

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with the upper surface of the bed frame. The axle 32 is preferably seated within an upright slot at each end of the bed frame (not shown) in order to prevent side to side movement of the axle whilst allowing the axle to be raised and lowered as described hereinbelow.

- 5 The cradle support frame raising mechanism 100 comprises an actuator 102 which is capable of extending and retracting in the same manner as that described in connection with Figure 8. Four pivotable raising arms 106 are coupled at intervals along the length of the bottom frame member 52, and each have a roller 108 which bears against a lower surface of the axle 32. The upper ends of the raising arms 106, adjacent the rollers 108, are connected together  
10 by way of a transmission bar 110. One of the raising arms 106 is coupled, intermediate its ends, to the extendable end of actuator 102.

With the actuator 102 in its retracted position, and thus the cradle support frame 30 in its lowered position, the raising arms 106 are acutely angled from the bottom frame member 52  
15 to their rollers 108 which bear against the axle 32. As the actuator 102 extends, this causes the raising arms 106, which are coupled together by way of the transmission bar 110, to raise up until perpendicular to the bottom frame member 52. Correspondingly, the rollers 108 press against the axle 32 so that as the raising arms 106 move the cradle support frame 30 is raised out of the bed frame until reaching a configuration such as that shown in Figure 11.  
20 The cradle support frame 30 is prevented from tilting from side to side during the raising operation by connection of the frame extensions 38 to a rocker actuator as will be described in greater detail hereinbelow.

As the cradle support frame 30 is raised from the lower position (Figure 10) to the upper  
25 position (Figure 11) the bed plate 10 (not shown in Figures 10 and 11) is lifted from its flat configuration supported by the upper frame members 56 of the bed frame, and forms a curved trough shape following the shape of the upper edges of the u-shaped frame members 34, by virtue of the flexible edge connections between the individual panels 12.

- 30 The articulating actuator mechanism 60 interfits with the cradle raising mechanism 100 within

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the bed frame and beneath the bed plate 10. The cradle support frame 30 is constructed to be shorter in length than the bed frame, which enables the head support cross member 76 and foot support cross member 84 of the articulating mechanism 60 to extend across the width of the bed plate 10 without interfering with the cradle support frame edge railings 36. The support arm 72 and lever arms 80 and 90, when extended, are arranged to extend upwardly between the top frame members 56 of the bed frame and edge railings 36 of the cradle support frame which is lowered within the bed frame. The gap 40 in the edge railings 36 is provided to enable the support cross member 86 to extend across the width of the bed plate and be connected to the longitudinal members 82 and lever arms 80 without interference between the articulating actuator mechanism and the cradle support frame during raising or lowering of either one.

Figures 12 and 13 are end cross sectional views of the bed 50, illustrating the cradle support frame 30 in the lowered and raised positions corresponding to Figures 10 and 11, respectively. Figures 12 and 13, as well as Figures 14 and 15 discussed below, also illustrate a rocker actuator 110 coupled between a side of the bed frame and the frame extensions 38 extending from the bottom of central u-shaped frame members 34 with the cradle support frame 30 in its raised position (Figure 13) the cradle support frame 30 is able to be tilted from the central position (Figure 13) to each side by extension (Figure 14) and retraction (Figure 15) of the rocker actuator 110. As shown in these Figures, extension of the actuator 110 causes tilting of the cradle support frame 30 about the axle 32 in a clockwise direction, and retraction of the actuator 110 causes tilting of the cradle support frame 30 about the axle 32 in an anti-clockwise direction. Preferably, in use, the cradle support frame is able to be tilted of the order of 20° to 30° to each side from the centred position. On the other hand, the angle of the extremities of the u-shaped frame members 34 with respect to the horizontal, when in the centred position, is preferred to be of the order of 60°. In this way, even at the extreme of tilting to each side, the lower edge of the cradle support frame 30 is still angled upwardly so as to reduce the risk of a patient rolling out of the bed.

In a preferred mode of operation of the bed, the cradle support frame 30, when in the raised

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position, is incrementally tilted from side to side over a total cycle comprising, for example, ten increments. Thus, at each incremental tilting movement the cradle support frame 30, and thus the bed plate 10 and mattress thereon may tilt by only several degrees. Furthermore, each incremental tilting movement is preferably followed by a timed interval of, for example, 5, 10 or 15 minutes, making a total rocking cycle 50, 100 or 150 minutes. In this way, distribution of pressure on the prone user can be achieved over a period of time, whilst avoiding any fast or sudden movements which may be upsetting.

The preferred embodiment of the invention is provided with a dedicated controller for the three actuators 62, 102 and 110 to allow operation thereof whilst preventing misuse. The controller may be embodied in a programmable logic chip which is coupled to pass electrical signals to each of the actuators in order to control the extension and retraction thereof. The PLC controller may be provided with or coupled to a timer in order to measure the time interval between incremental tilting movements as described above. Preferably, the controller is provided in a hand control or panel accessible by the bed user for convenient control of the bed functions.

Figure 26 is a block diagram of an example of a controller 200, comprising a key pad 210 which provides input to a programmable logic chip 220. The PLC 220 is also coupled to a timer 240, and is arranged to pass control signals to the three actuators 62, 102 and 110, also labelled A1, A2 and A3, respectively. The key pad 210 is provided with several push buttons operable by the bed user. A "flat" button is provided for returning the bed to its flat position. A "sit" button is provided for articulating the bed plate and mattress into a sitting orientation. A "raise" button is provided for raising the cradle support frame so as to form the bed plate and mattress into the trough shaped configuration. A "lower" button is provided for lowering the cradle support frame so as to return the bed plate to the flat position. A "rock" button is provided to initiate the cyclical rocking or tilting of the cradle support frame. A "stop" button is provided for stopping the cyclical tilting of the bed and returning the cradle support frame to its centred position. Interval timer buttons marked "5", "10" and "15" are provided to enable the user to select the time interval between incremental tilting movements during

the rocking operation of the bed. Alternatively, the interval timer programming functions of the controller may be multiplexed onto the other function buttons or a combination thereof.

Figures 19 to 25 are flow chart diagrams illustrating an example of a control algorithm which may be implemented by the PLC 220 in order to control operation of the actuators A1 (62), A2 (102) and A3 (110) in accordance with buttons pressed on the control panel 210. The illustrated flow charts employ flags F1, F2 and F3 which may be software implemented or be implemented through the use of flip flops or the like. The flags are utilised in order to keep track of the current positions of the actuators A1, A2 and A3, respectively. In particular, flag F1 is set or reset according to whether the actuator A1 is extended or retracted, flag F2 is set or reset according to whether the actuator A2 is extended or retracted, and flag F3 is reset or set according to whether the actuator A3 is centred or not centred. Alternatively, the flags may be implemented through the use of feedback signals from the actuators A1, A2 and A3, which is in fact preferred. In this way, the flags F1, F2 and F3 would be set or reset not by the PLC control algorithm itself, but by virtue of signals received from the actuators indicating positional information.

Referring firstly to Figure 19, at the beginning of the control algorithm the bed is in its flat configuration, and flags F1, F2, and F3 are reset (step 310). Input from the control panel 210 is received by the controller at step 312, and steps 314 to 326 are utilised to determine which button has been pressed and thus direct the algorithm to the appropriate procedure of those illustrated in Figures 20 to 25. If the "sit" button is pressed (step 316) the algorithm is directed to the procedure shown in the flow chart of Figure 20. If the "flat" button is pressed (step 318) then the algorithm is directed to the procedure shown in the flow chart of Figure 21. If the "raise" button is pressed (step 320) then the algorithm is directed to the procedure shown in the flow chart of Figure 22. If the "lower" button is pressed (step 322) then the control algorithm is directed to the procedure shown in the flow chart of Figure 23. If the "rock" button is pressed (step 324) then the control algorithm is directed to the procedure shown in the flow chart of Figure 24. Finally, if the "stop" button is pressed (step 326) then the control algorithm is directed to the procedure shown in the flow chart of Figure

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25.

If the "sit" button is pressed, the algorithm is directed to the procedure illustrated in the flow chart of Figure 20, which first checks to determine whether either of the flags F1 or F2 are set. If flag F1 is set, this indicates that the bed is already in a sitting configuration, and in this case the control algorithm is directed back to point "X" of the flow chart in Figure 19. If the flag F2 is set, this indicates that the cradle support frame is in the raised position, which precludes articulation of the bed plate into the sitting configuration. If neither of F1 and F2 are set, then the actuator A1 is activated so as to extend and move the bed into the sitting configuration. Flag F1 is set, and the control algorithm returns for the next control operation.

When the "flat" button is pressed, the procedure of Figure 21 is utilised. As with the "sit" procedure, both flags F1 and F2 are examined, and in this case the actuator A1 is activated in order to retract only in the case that F1 is set and F2 reset.

Figure 22 illustrates the procedure for the "raise" operation, for raising the cradle support frame from the bed frame in order to lift and form the bed plate into the trough shaped configuration. The procedure is similar to that shown in Figure 20, in that flags F1 and F2 are examined and the procedure bypassed if either is set. If both F1 and F2 are not set, then actuator A2 is activated in order to extend to thereby raise the cradle support frame, and flag F2 is set. For the "lower" procedure shown in Figure 23 it is flags F2 and F3 which are examined before retraction of actuator A2. The actuator A2 is only activated if F2 is set indicating the cradle support frame is in the raised position, and flag F3 is not set which indicates that the cradle support frame is centred about its axis and thus suitable for lowering into the bed frame.

Figure 24 illustrates the procedure for initiating the cyclical rocking or tilting motion of the cradle support frame when the "rock" button is pressed on the control panel. Flag F3 is examined firstly to determine whether the rocking function has been initiated, and if so the



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control algorithm returns to the flow chart of Figure 19. Flag F2 is then examined to ensure that the cradle support frame is in the raised position (ie F2 is set). If F3 is reset and F2 is set, then the PLC controller initiates the cyclical tilting using actuator A3, and flag F3 is set. For the "rocking" process, the PLC 220 utilises the timer 240 in accordance with which one  
5 of the timer intervals is currently active. For example, if the "10" minute interval has been selected on the control panel 210, the timer 240 is programmed to generate a control signal each 10 minutes. When a control signal is received from the timer, the PLC issues an incremental movement signal to drive the actuator A3 through an incremental extension or retraction so as to tilt the cradle support frame incrementally to one side or the other,  
10 depending upon the current direction of movement. A counter is maintained by the PLC in order to keep track of whether the current tilting movement is in the clockwise or counter-clockwise direction. When the counter is incremented or decremented each time a tilting movement takes place, and when the counter indicates that the cradle support frame is fully tilted to one side or the other, the direction of movement of the actuator is reversed for the  
15 next incremental movement. Selecting a timer interval on the control panel, in this case by pressing one of the timer selection buttons "5", "10" or "15" causes the timer 240 to be set by the PLC to the time interval selected by the user.

If the "stop" button is pressed on the control panel, the procedure of Figure 25 is executed,  
20 which first examines the flag F3 to determine that the bed is currently in the cyclical rocking mode. If so, the actuator A3 is driven by the controller in order to return the cradle support frame to the centred position, suitable for lowering thereof. Flag F3 is then reset, and the control procedure returns to point "X" of the flow chart illustrated in Figure 19.

25 In the preferred embodiment, the three actuators A1, A2, A3 (62, 102, 110) are electrically operated, and suitable linear actuators are available from, for example, Magnetic Elektromotoren AG of Liestal, Switzerland or Warner Electric of Illinois, USA. The preferred actuators operate on a driving voltage of 24 volts d.c., and are provided with a backup battery to enable operation of the bed functions in the event of a mains power failure.

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Throughout this specification and the claims which follow, unless the context requires otherwise, the word "comprise", or variations such as "comprises" or "comprising", will be understood to imply the inclusion of a stated integer or group of integers but not the exclusion of any other integer or group of integers.

5

The foregoing detailed description of the preferred embodiment of the present invention has been presented by way of example only, and is not intended to be considered limiting to the invention, which includes every novel feature and novel combination of features herein disclosed.

10

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## CLAIMS:

1. A bed having a mattress support assembly which is moveable between a flat configuration and a trough shaped configuration and, when in said trough shaped  
5 configuration, is tiltable from side to side with respect to its longitudinal axis.
2. A bed as claimed in claim 1, including a first mechanism for raising at least the opposing longitudinal edges of the mattress support assembly with respect to the centre thereof in order to form the support assembly into said trough shaped configuration from said  
10 flat configuration.
3. A bed as claimed in claim 1 or 2, wherein the mattress support assembly has a substantially arcuate upwardly concave cross-sectional profile when formed in said trough shaped configuration.
- 15 4. A bed as claimed in claim 2, including a substantially flat and horizontal frame on a base of the bed and arranged to support the mattress support assembly in said flat configuration, and a cradle support frame within the bed base which is relatively movable with respect to the flat frame into an operative position so as to form and support the mattress  
20 support assembly in said trough shaped configuration.
5. A bed as claimed in claim 4, wherein said cradle support frame is mounted on a longitudinally extending axle and is movable about the axle when in said operative position to tilt the mattress support assembly from side to side.
- 25 6. A bed as claimed in claim 5, including a tilting actuator for moving said cradle support frame about said axle, the tilting actuator being controlled so as to incrementally tilt the mattress support assembly from side to side in series of steps.
- 30 7. A mattress support assembly for a bed adapted for use by long term infirm persons,

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the mattress support assembly comprising a bed plate on which a mattress is in use positioned, and an actuating means for moving the bed plate from a first configuration in which the bed plate is supported in a substantially flat and horizontal orientation to a second configuration in which the bed plate is supported in a longitudinal trough shaped arrangement, the actuating  
5 means being further arranged for tilting the bed plate from side to side with respect to a longitudinal axis when in said second configuration.

8. A mattress support assembly as claimed in claim 7, wherein the bed plate comprises a plurality of longitudinal panels which are hingedly coupled to one another to enable the bed  
10 plate to flex about its longitudinal axis.

9. A mattress support assembly as claimed in claim 7 or 8, wherein in said first configuration the bed plate is supported on a substantially flat and horizontal support frame coupled to a bed base.

15

10. A mattress support assembly as claimed in claim 9, further comprising a cradle support frame is provided beneath the bed plate and having a plurality of generally u-shaped frame members spaced along the longitudinal length of the bed plate, wherein the cradle support frame is relatively moveable with respect to the flat support frame in such a way as  
20 to allow the cradle support frame to be raised above the flat support frame, in use, taking with it the bed plate so as to form the bed plate into said second configuration.

11. A mattress support assembly as claimed in claim 10, wherein said actuating means comprises a first actuator for effecting said relative movement of the cradle support frame and  
25 flat support frame, to facilitate movement of the mattress support assembly between said first and second configurations.

12. A mattress support assembly as claimed in claim 11, wherein said cradle support frame is mounted for pivotal movement about said longitudinal axis, and wherein said  
30 actuating means further comprises a second actuator provided for pivoting the cradle support

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frame from side to side when the mattress support assembly is in said second configuration.

13 A mattress support assembly as claimed in claim 12, further comprising a control means for controlling said first and second actuators, the control means being effective to, in  
5 use, control said second actuator to cyclically tilt the cradle support frame from side to side during a predetermined interval.

14. A mattress support assembly as claimed in claim 13, wherein the control means is further effective to control the second actuator to carry out said cyclic tilting in a series of  
10 incremental movements.

15. A mattress support assembly as claimed in claim 14, wherein the control means is programmable to enable the time intervals between incremental movements and/or the size of each incremental movement to be adjusted.  
15

16. A mattress support assembly as claimed in claim 7, wherein the bed plate is hinged at points along its longitudinal extent to enable sections thereof to be angled transversely of the longitudinal axis.

20 17. A mattress support assembly as claimed in claim 16, further comprising a third actuator arranged to move the bed plate between said first configuration and a third configuration in which the bed plate is articulated at said hinged points to form enable a user to be supported on the bed plate in a seated position.

25 18. A mattress support assembly for a bed comprising a longitudinal bed plate for support of a mattress, the bed plate being flexible perpendicular to its longitudinal axis to enable the bed plate to be moved from a first configuration in which the bed plate is supported substantially flat and horizontal to a second configuration in which the bed plate is flexed about its longitudinal axis and supported in a trough shaped arrangement, the mattress support  
30 assembly including means for tilting the bed plate from side to side when in said trough

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shaped arrangement.

19. A mattress support assembly as claimed in claim 18, wherein the bed plate comprises a plurality of longitudinal panels which are hingedly coupled to one another to enable the bed  
5 plate to flex about its longitudinal axis.

20. A mattress support assembly as claimed in claim 18, wherein in said first configuration the bed plate is supported on a substantially flat and horizontal support frame coupled to a bed base, and wherein a cradle support frame is provided beneath the bed plate  
10 and having a plurality of generally u-shaped frame members spaced along the longitudinal length of the bed plate, the cradle support frame being relatively moveable with respect to the flat support frame in such a way as to allow the cradle support frame to be raised above the flat support frame, in use, taking with it the bed plate so as to form the bed plate into said  
trough shaped arrangement.

15

21. A mattress support assembly as claimed in claim 20, further comprising a first actuator for effecting said relative movement of the cradle support frame and flat support frame, to facilitate movement of the mattress support assembly between said first and second configurations.

20

22. A mattress support assembly as claimed in claim 21, wherein said cradle support frame is mounted for pivotal movement about said longitudinal axis, and wherein a second actuator is provided for pivoting the cradle support frame from side to side when the mattress support assembly is in said second configuration.

25

23. A mattress support assembly as claimed in claim 22, further comprising a control means for controlling said first and second actuators, the control means being effective to, in use, control said second actuator to cyclically tilt the cradle support frame from side to side during a predetermined time period.

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24. A mattress support assembly as claimed in claim 23, wherein the control means is further effective to control the second actuator to carry out said cyclic tilting in a series of incremental movements.

5 25. A mattress support assembly as claimed in claim 24, wherein the control means is programmable to enable the time intervals between incremental movements and/or the size of each incremental movement to be adjusted.

26. A mattress support assembly as claimed in any one of claims 18 to 25, wherein the  
10 bed plate is hinged at points along its longitudinal extent to enable sections thereof to be angled transversely of the longitudinal axis.

27. A mattress support assembly as claimed in claim 26, further comprising a third actuator arranged to move the bed plate between said first configuration and a third  
15 configuration in which the bed plate is articulated at said hinged points to form enable a user to be supported on the bed plate in a seated position.

28. A bed adapted for long term infirm persons, comprising:  
a base having a substantially horizontal support frame;  
20 a mattress support assembly comprising a longitudinal bed plate for use in supporting a mattress thereon, the bed plate being flexible perpendicular to its longitudinal axis, the mattress support assembly further comprising a cradle support frame positioned beneath said bed plate; and

actuating means coupled between the base and mattress support assembly for  
25 movement thereof with respect to the base, the actuating means comprising a first actuator for moving the bed plate from a first position wherein the bed plate is supported substantially flat and horizontal on the support frame of the base to a second position wherein the bed plate is supported by said cradle support frame in a trough shaped configuration, flexed about its longitudinal axis, and a second actuator for tilting the cradle support frame and bed plate  
30 when in said second position from side to side with respect to said longitudinal axis.

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29. A bed as claimed in claim 28, further comprising a control means for controlling said first and second actuators, the control means being effective to, in use, control said second actuator to cyclically tilt the cradle support frame from side to side during a predetermined time period.

5

30. A bed as claimed in claim 29, wherein the control means is further effective to control the second actuator to carry out said cyclic tilting in a series of incremental movements.

31. A bed as claimed in claim 30, wherein the control means is programmable to enable  
10 the time intervals between incremental movements and/or the size of each incremental movement to be adjusted.

32. A bed as claimed in any one of claims 28 to 31, wherein the bed plate is hinged at  
15 points along its longitudinal extent to enable sections thereof to be angled transversely of the longitudinal axis.

33. A bed as claimed in claim 32, further comprising a third actuator arranged to move the bed plate between said first position and a third position in which the bed plate is articulated at said hinged points to form enable a user to be supported on the bed plate in a  
20 seated position.



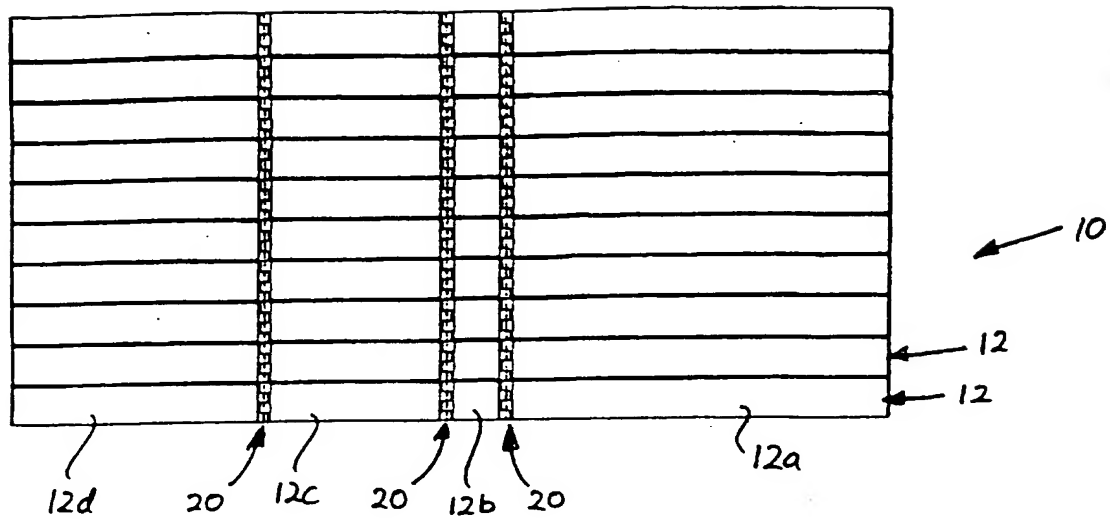


Figure 1

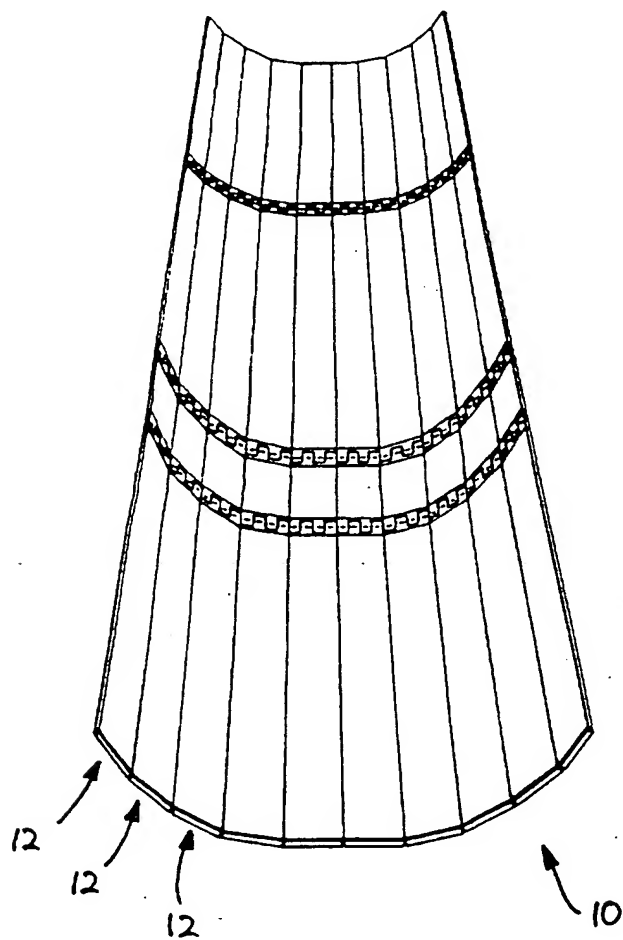


Figure 2

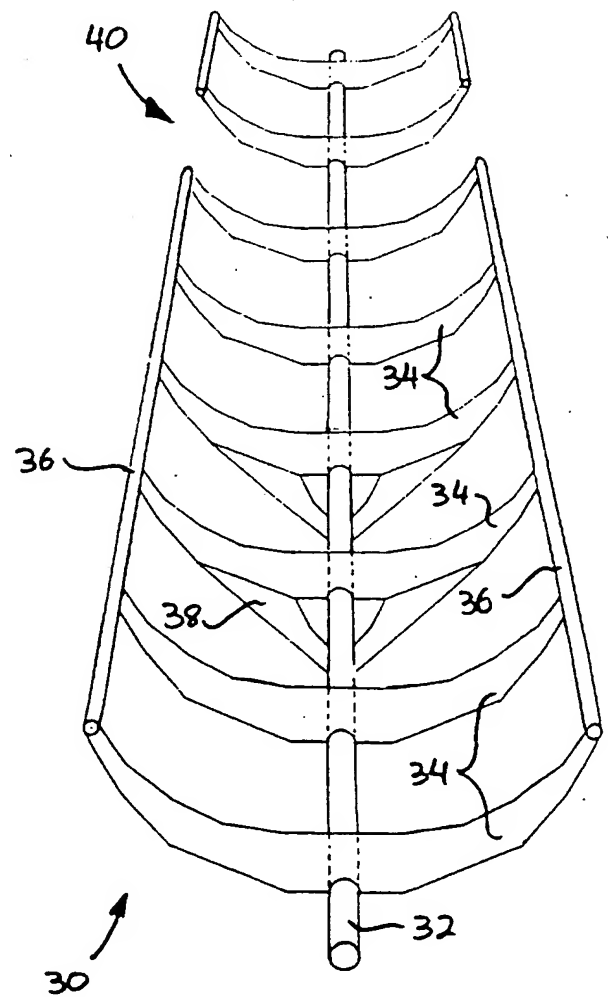


Figure 3

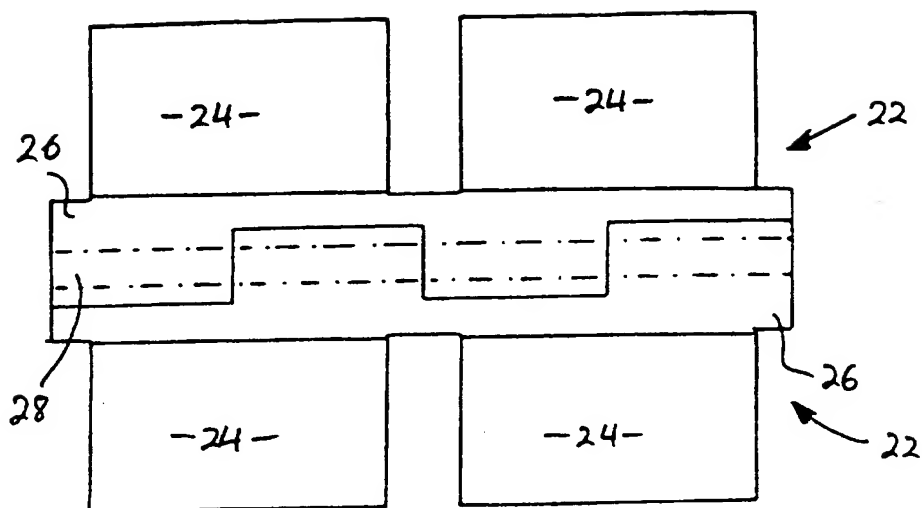


Figure 4

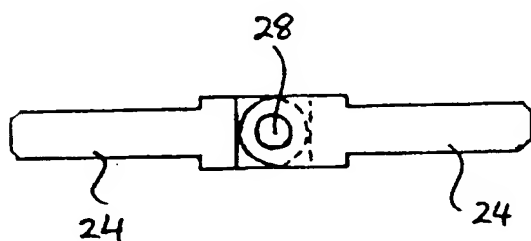


Figure 5

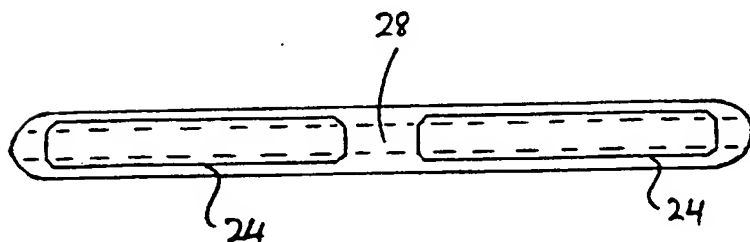


Figure 6

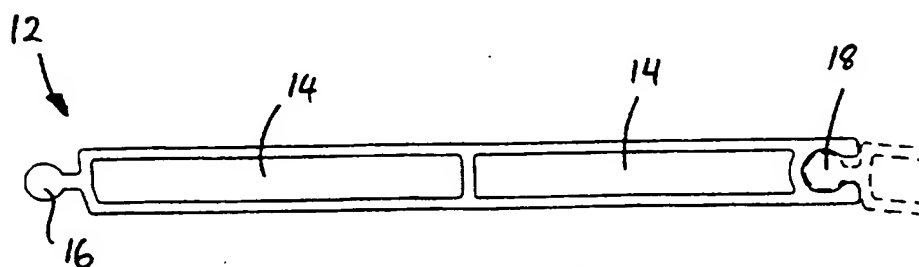


Figure 7

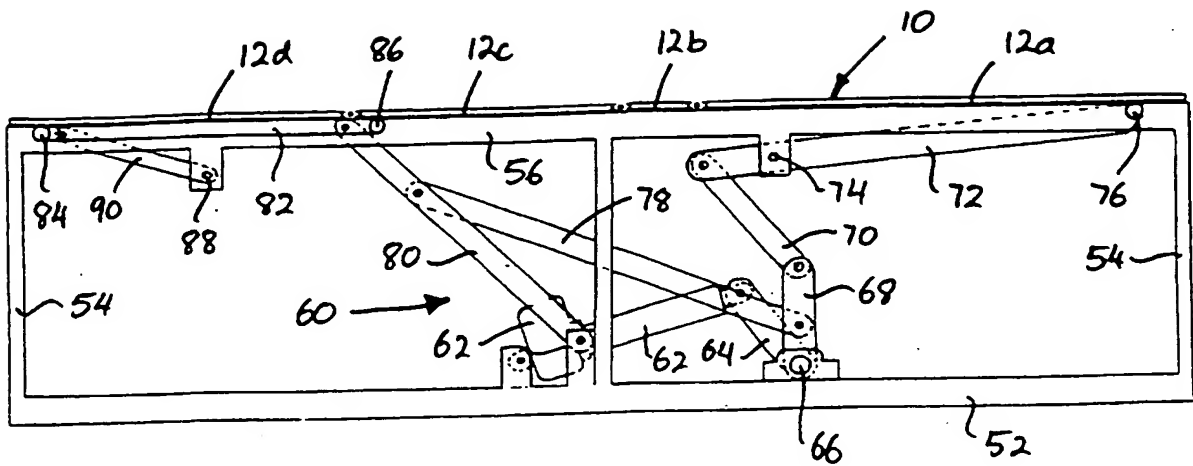


Figure 8

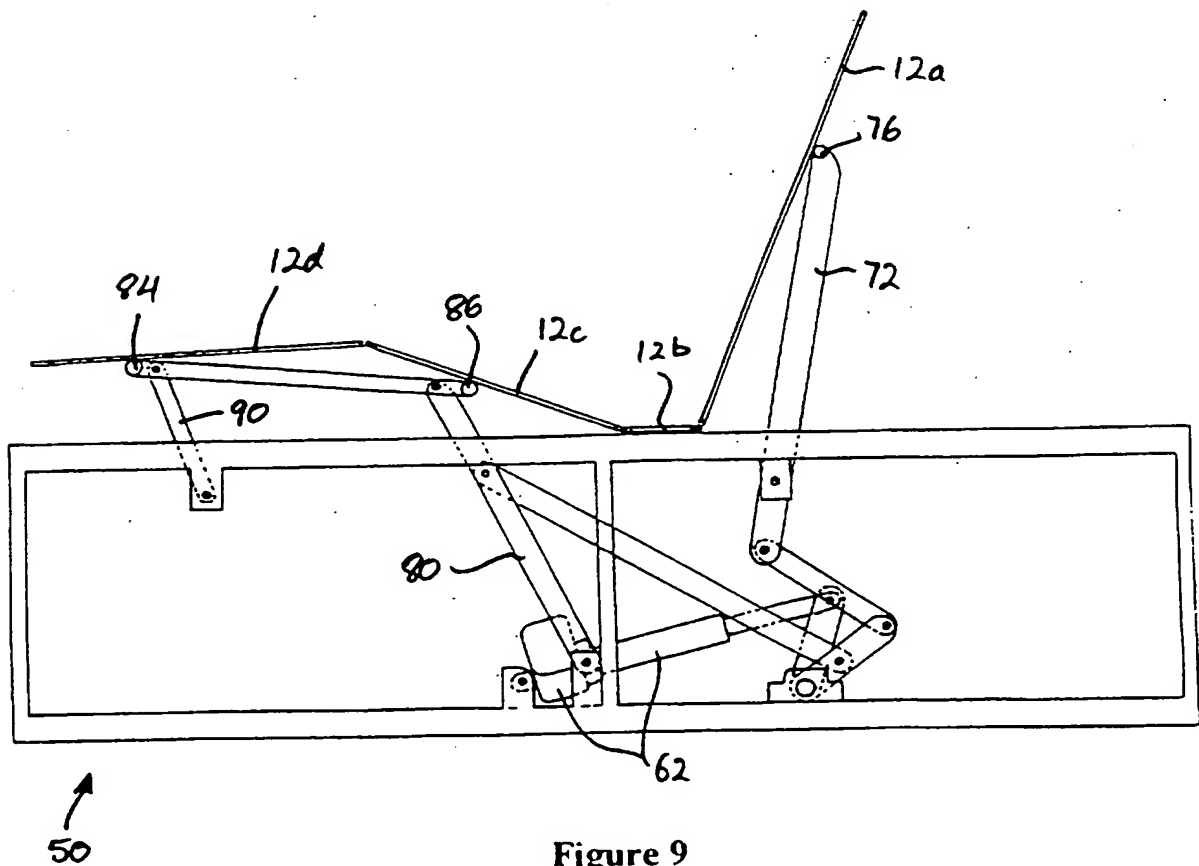
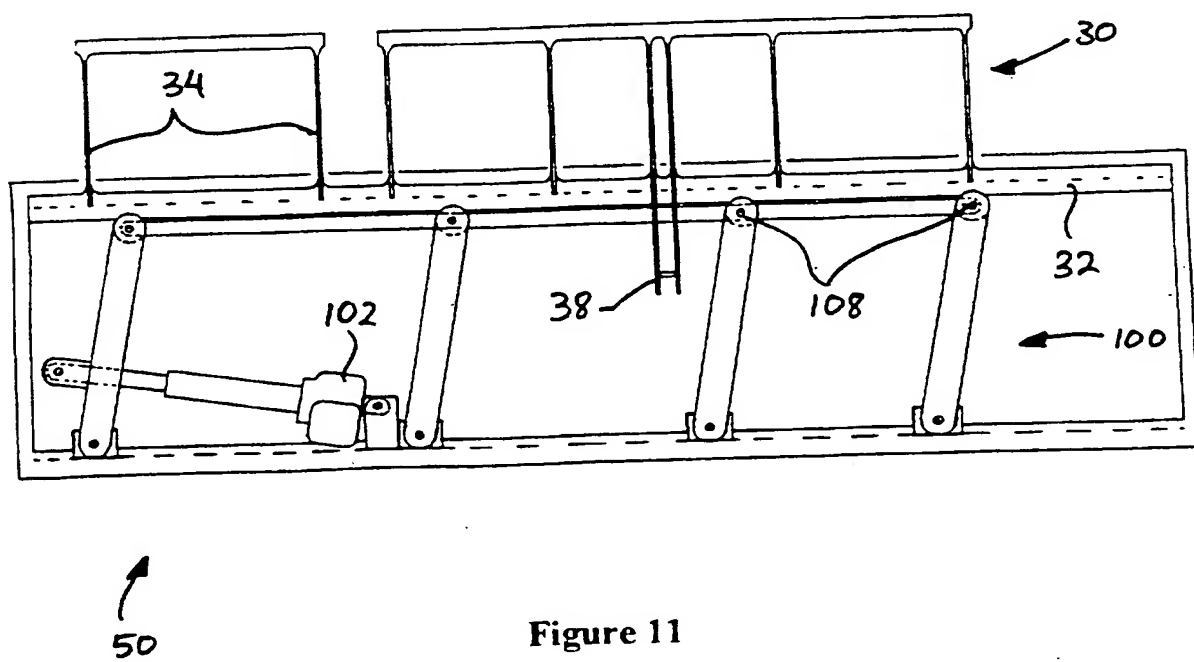
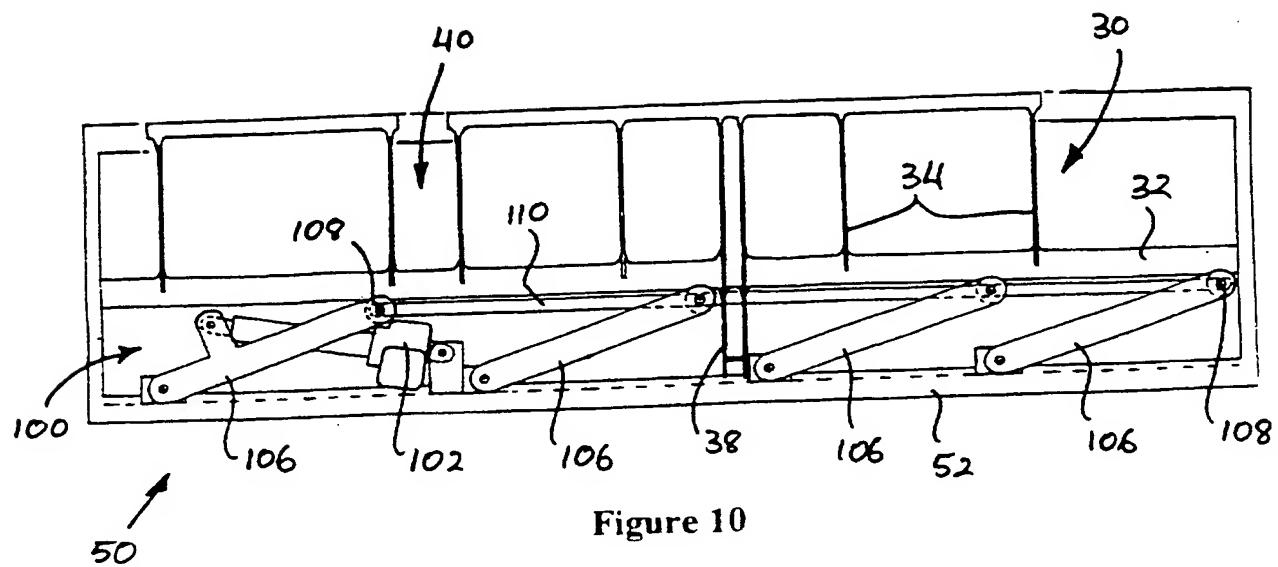


Figure 9



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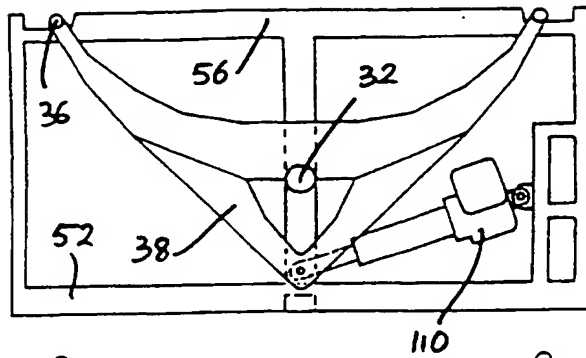


Figure 12

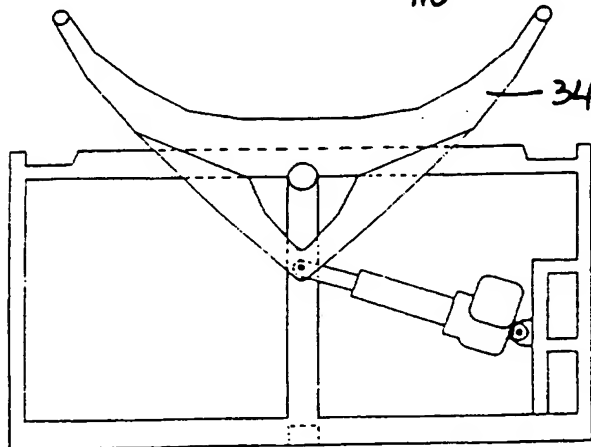


Figure 13

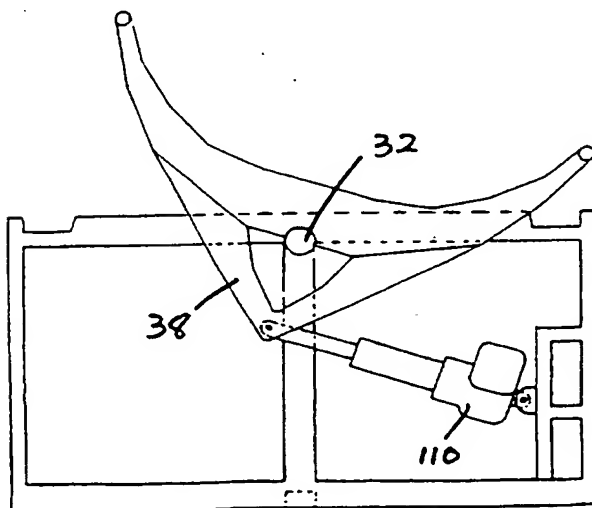


Figure 14

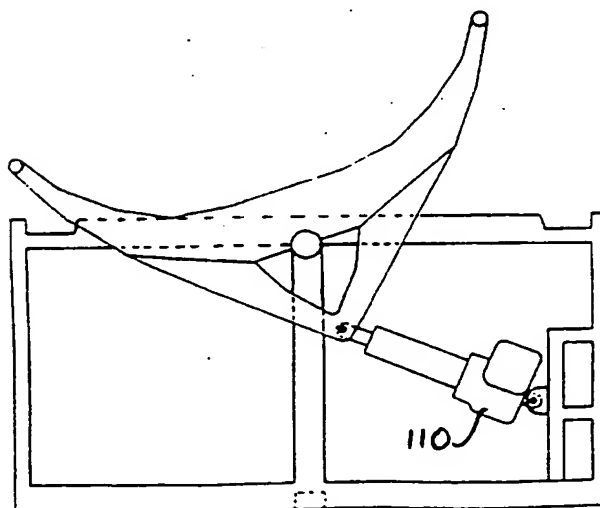


Figure 15

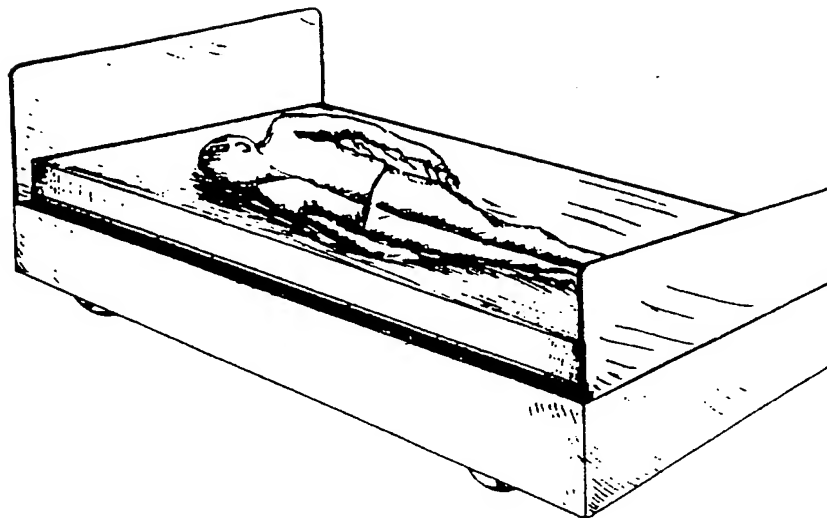


FIGURE 16.

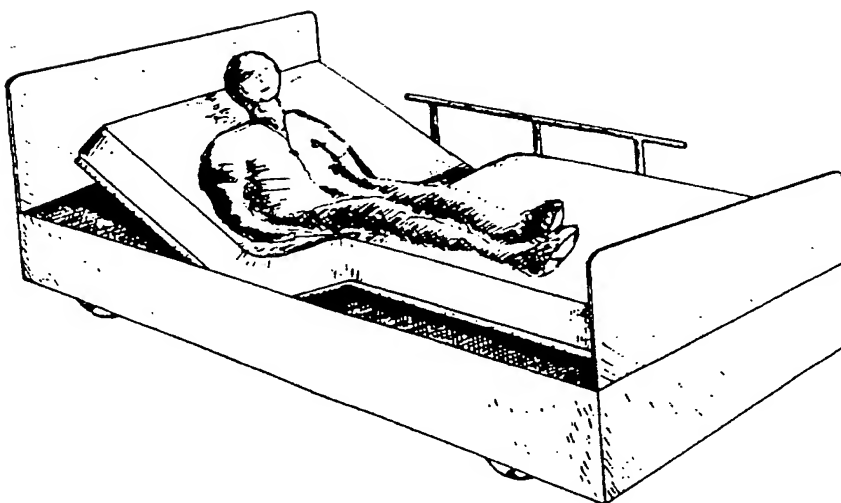


FIGURE 17.

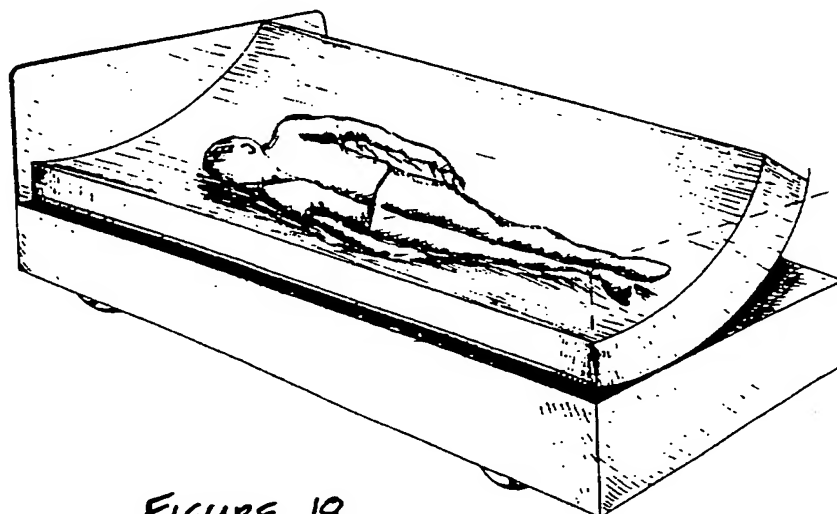


FIGURE 18.

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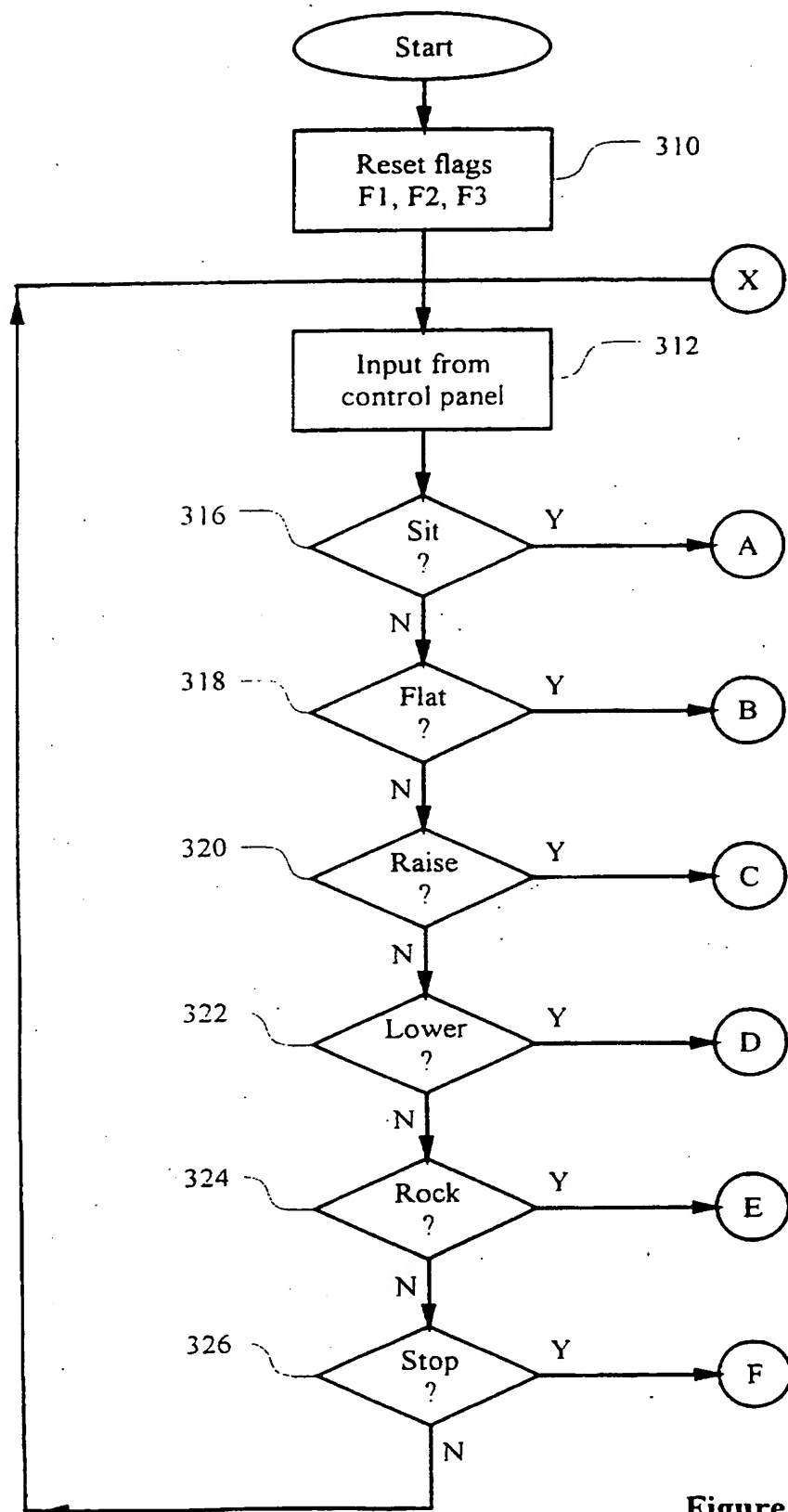


Figure 19

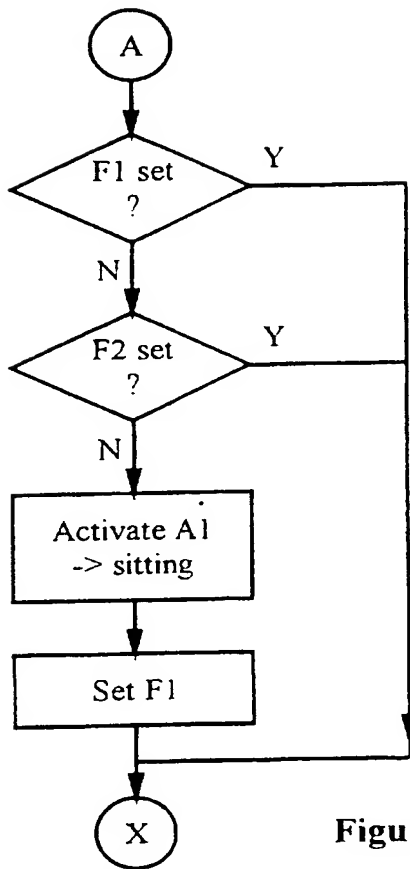


Figure 20

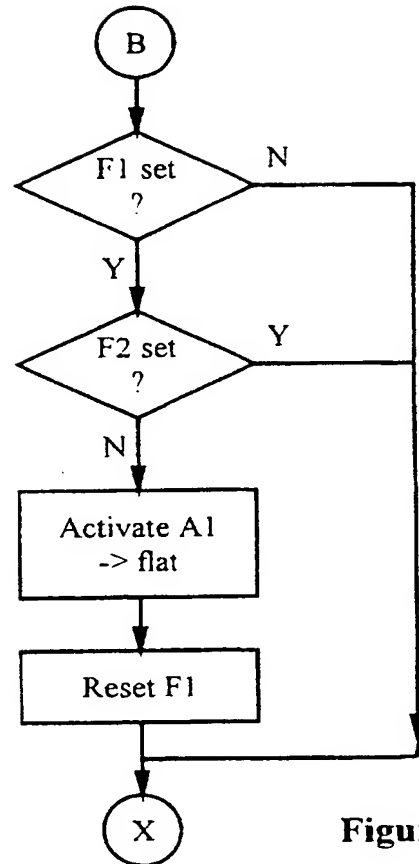


Figure 21



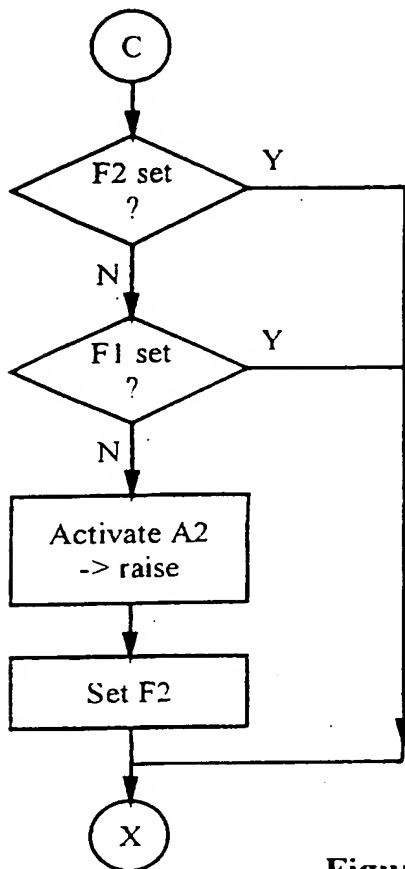


Figure 22

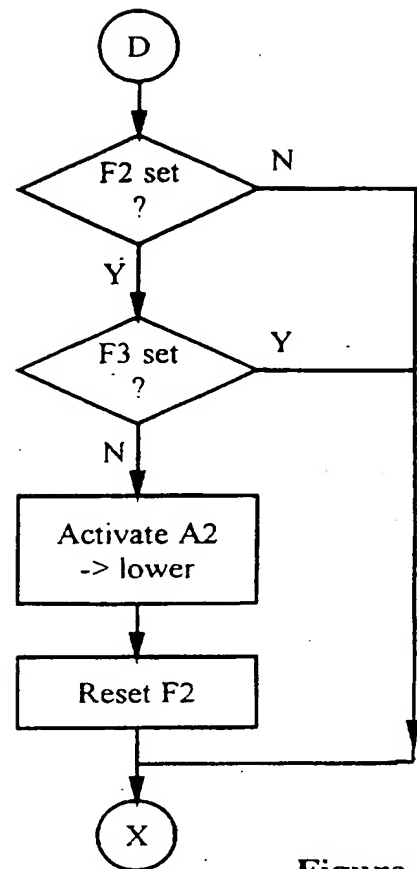


Figure 23

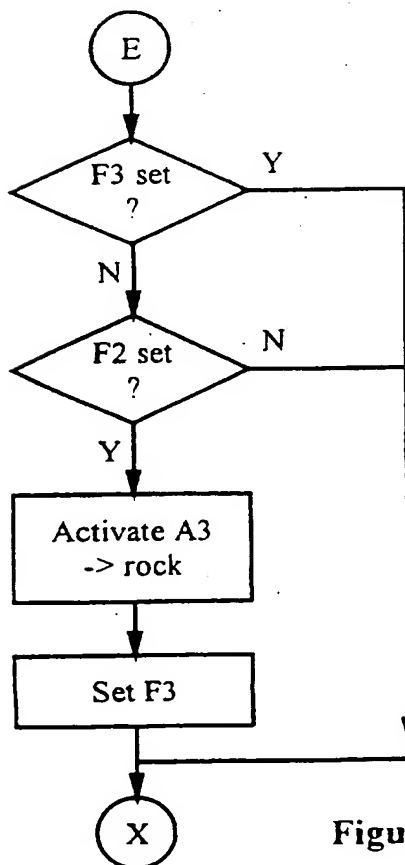


Figure 24

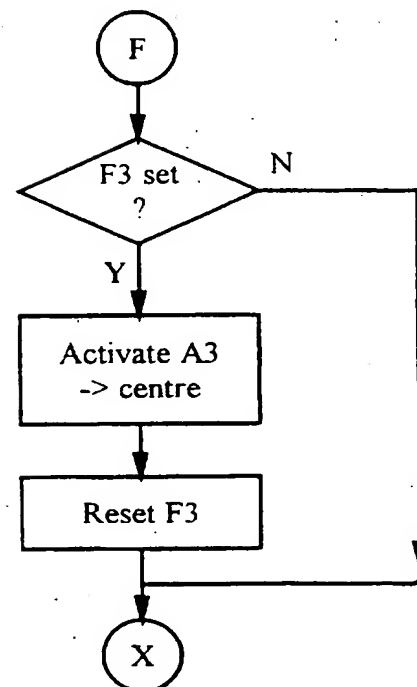
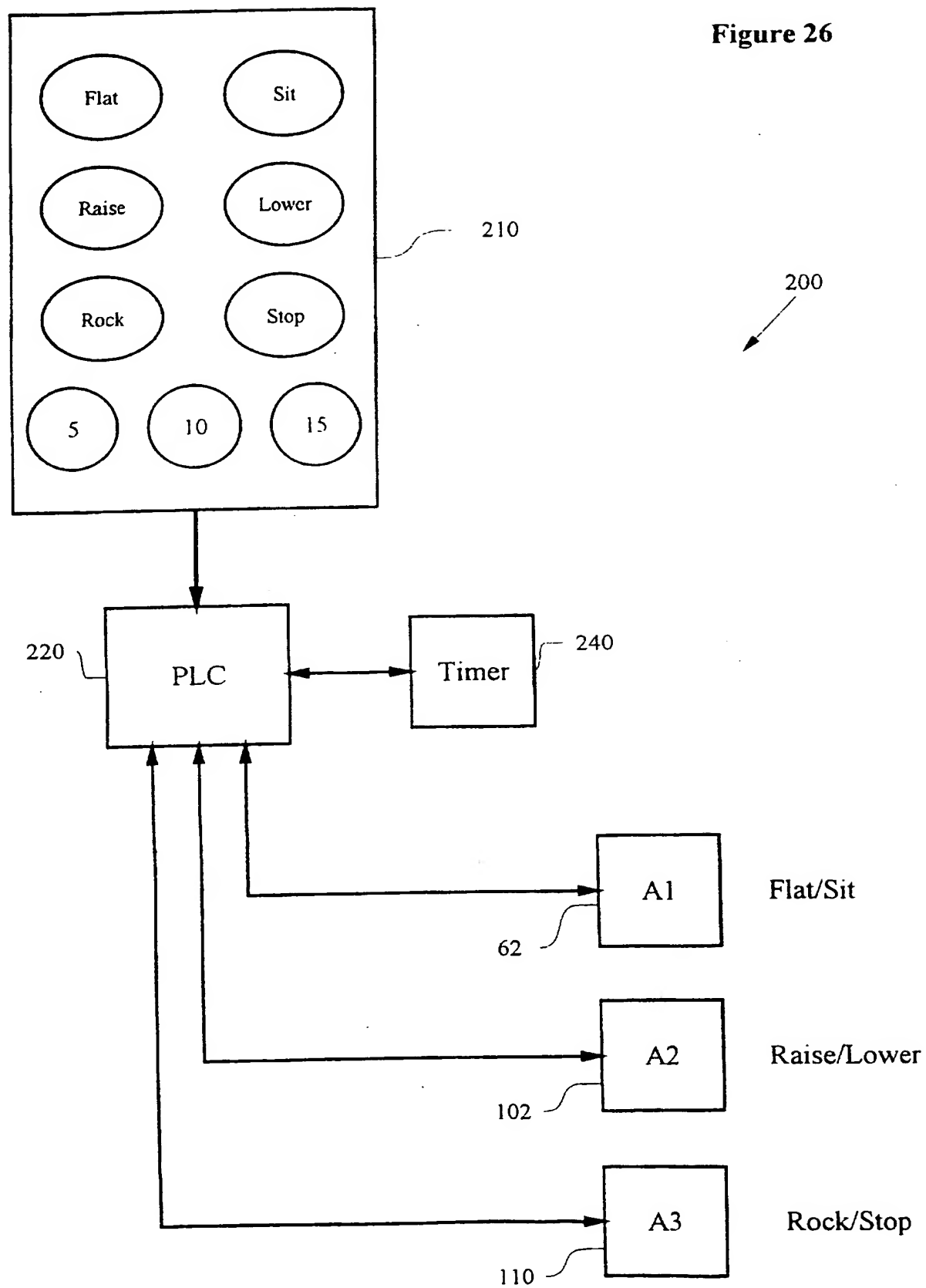


Figure 25

Figure 26



# INTERNATIONAL SEARCH REPORT

International Application No.  
PCT/AU 97/00618

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int Cl <sup>6</sup> : A61G 7/057, 7/008		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols) IPC : A61G 7/00, 7/057, 7/008, A47C		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched AU : IPC as above		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) DERWENT JAPIO		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P,X	WO A 97/30674 (HAUGS) 28 August 1997 Page 10 lines 1-36, page 14 lines 11-25, page 15 line 14 - page 17 line 15	1-4, 7-9, 16-19, 26-33
X	US A 3875598 (FOSTER et al.) 8 April 1975 Column 4 line 10 - column 7 line 61, column 14 lines 11-23	1-7, 9, 16-18, 26-33
X	GB A 2045603 (EGERTON HOSPITAL EQUIPMENT LTD) 5 November 1980 Page 1 line 33-70, lines 114-117	1-7, 9, 18, 28-31
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C <input type="checkbox"/> See patent family annex		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 23 October 1997		Date of mailing of the international search report 29 OCT 1997
Name and mailing address of the ISA/AU AUSTRALIAN INDUSTRIAL PROPERTY ORGANISATION PO BOX 200 WODEN ACT 2606 AUSTRALIA Facsimile No.: (02) 6285 3929		Authorized officer  JOHN HO Telephone No.: (02) 6283 2329

# INTERNATIONAL SEARCH REPORT

International Application No.

PCT/AU 97/00618

C (Continuation)

## DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP A 262771 (TURNBLADE LTD.) 6 April 1988 Column 1 line 29 - column 2 line 49	1-4, 7-9, 16-18, 26-33
A	WO A 94/09686 (GEOMARINE SYSTEMS INC.) 11 May 1994 Figure 2	
A	EP A 374784 (ITALPRES S.n.c. die Fregni Bruno & C.) 27 June 1990 Figures 1-5	
A	US A 5103511 (SEQUIN) 14 April 1992 Column 5 line 28 - column 6 line 42	
A	EP A 604242 (PARAMOUNT BED COMPANY LTD.) 29 June 1994 Entire document	

## INTERNATIONAL SEARCH REPORT

International Application No.

**PCT/AU 97/00618**

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report			Patent Family Member		
WO	9730674	NO	960760		
US	3875598				
GB	2045603	JP	55133222	US	4357722
EP	262771				
WO	9409686	EP	673217	US	5375273
EP	374784	IT	1225494	US	5018225
US	5103511				
EP	604242	JP	5285746		
END OF ANNEX					

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